



US Army Corps  
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# DCAF Bulletin

## Design Construction Analysis Feedback

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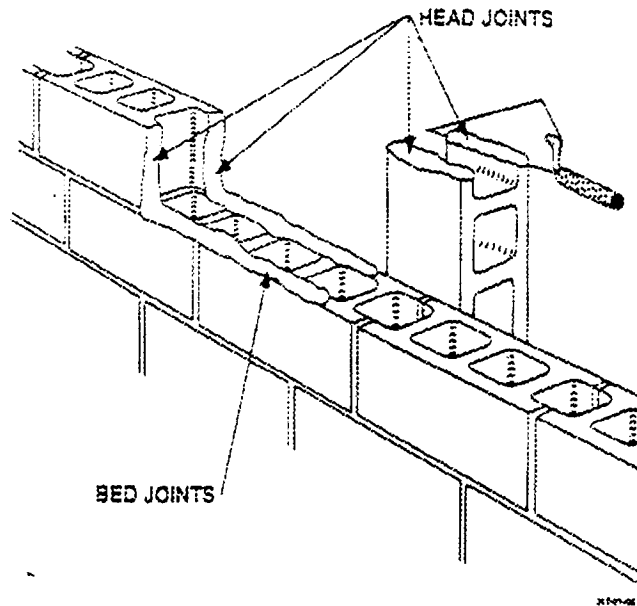
**Subject:**              Efflorescence in Masonry (CEGS 04200)

**Applicability:**      Information

**DISCUSSION:** The potential for efflorescence exists whenever brick and masonry units are used in construction. This condition is not harmful in itself but is an unsightly condition that gives the appearance of an inferior product. There have been many studies done on the causes and prevention of efflorescence, but the problem continues to cause concern at installations throughout the Army, Air Force, and other agencies. Efflorescence is a deposit of water-soluble salts left on masonry surfaces as water evaporates. Three conditions must exist before efflorescence occurs: (1) there must be water soluble salts present in the masonry units or mortar, (2) there must be sufficient moisture in the masonry to dissolve the salts, and (3) there must be a path for the dissolved salts to migrate to the surface where the moisture can evaporate. Elimination of any one of these factors will prevent efflorescence.

**PROBLEM:** Poor craftsmanship employed in the construction of a masonry wall has a significant effect on the amount of water penetrating the wall. It is imperative that joints be constructed as required by CEGS 04200. Paragraph 3.2, Laying Masonry Units, requires "Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion and isolation joints, shall be completely filled with mortar." Paragraph 3.2.3, Concrete Masonry Units, requires "Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be fully bedded in mortar under both face shells and webs. Other units shall be fully bedded in mortar under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell." CEGS 3.1.2.2 outlines protection of newly constructed masonry. It is a good idea to protect unfinished masonry from weather at any time when it is not being worked on. See figure 1 which details head and bed joints. If these joints are not completely filled, rain water will penetrate the wall- more easily.

**SOLUTION:** Since workmanship affects water permeability of more than any other factor, insistence on high quality work will help measurably in avoiding efflorescence. Since the most accessible points for entrance of water are the junctures of brick and mortar, unbonded and unfilled mortar joints must not be allowed. Decreasing the soluble salts and water present in masonry materials and prevent the passage of water by having tight joints between all masonry units and the mortar.



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Figure 1

**PROBLEM:** Improper or inaccurate mixing of mortar can help to cause efflorescence. The use of type M mortar has contributed to efflorescence.

**SOLUTION:** Proper mortar proportioning is an effective method in mitigating efflorescence. High-strength mortars apparently lead to debonding between the mortar and the brick, increasing water penetration and leading to efflorescence. Paragraph 2.10, Mortar, requires "Type S or N mortar in accordance with the proportions specifications of ASTM C 270. For type S mortar, use 1 part cement,  $\frac{1}{2}$  part lime and  $4 \frac{1}{2}$  parts aggregate. For type N mortar, use 1 part cement, 1 part lime and 6 parts aggregate. Do not use type M mortar. Mortar shall be mixed in a mechanically operated mixer for at least 3 minutes, but not more than five minutes. Measurement for ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes.

**SPECIFICATION:** Specifications should provide materials which will minimize soluble salts washed sand that meets the requirements of ASTM C33 (ASTM 1992b), low alkali cement, dehydrated lime free from calcium sulfate, clean mixing water (no salt water), and brick which passes the efflorescence tests in ASTM C67 (ASTM 1992d).

**CONSTRUCTION PRACTICE:** During construction, proper practices must be observed. These are being certain that the mixer, mortar box, mortarboards, and tools are not contaminated or corroded, and storing CMU and bricks in a manner that avoids saturation by rain, snow, or

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groundwater. During actual construction vapor barriers specified must be carefully and completely applied, walls must be covered with a waterproof membrane at the end of each day's work or when rain is expected, pay attention to proper installation of water stops, flashing etc., and tool all mortar joints with a V- or concave-shaped jointer to compact the mortar and create a tight bond between mortar and masonry.

CONCLUSION: The use of properly designed and mixed mortar and following good construction practices and completely filling head and bed joints will go a long way toward mitigating efflorescence in masonry. If masonry does develop an efflorescent problem washing of the walls and natural dissipation of efflorescence over time appear to be the most-effective method of correcting the problem. Testing by Waterways Experiment Station has shown that application of sealants are generally ineffective in controlling efflorescence and may cause other problems.



KISUK CHEUNG, P.E.

Chief, Engineering and Construction Division